



Marked-Up Copy of Amendments Submitted With
Amendment; Response To Office Action Mailed January 23, 2003

In the Specification:

On page 64, the paragraph beginning on line 11:

As shown in FIG. 3, in addition to heat sources 100, one or more production wells 104 ~~102~~ will typically be disposed within the portion of the coal formation. Formation fluids may be produced through production well 104. ~~Production well 102 may be configured such that a mixture that may include formation fluids may be produced through the production well.~~ Production well 104 ~~102~~ may also include a heat source. In this manner, the formation fluids may be maintained at a selected temperature throughout production, thereby allowing more or all of the formation fluids to be produced as vapors. Therefore high temperature pumping of liquids from the production well may be reduced or substantially eliminated, which in turn decreases production costs. Providing heating at or through the production well tends to: (1) ~~prevent~~ inhibit condensation and/or refluxing of production fluid when such production fluid is moving in the production well proximate to the overburden, (2) increase heat input into the formation, and/or (3) increase formation permeability at or proximate the production well.

In the Claims:

4091. (amended) A system configured to heat a hydrocarbon containing formation, comprising:
one or more ~~heat source~~ heaters disposed ~~within~~ withinin one or more open wellbores in the formation, wherein the one or more ~~heat source~~ heaters are configured to provide heat to at least a portion of the formation during use; ~~and~~
wherein the system is configured to allow heat to transfer from the one or more ~~heat source~~ heaters to a ~~selected section~~ part of the formation during use; ~~and~~
wherein the system is configured to maintain a temperature in the part of the formation in a pyrolysis temperature range.

4092. (amended) The system of claim 4091, wherein the one or more ~~heat source~~heaters comprise at least two ~~heat source~~heaters, and wherein superposition of heat from at least the two ~~heat source~~heaters pyrolyzes at least some hydrocarbons ~~within~~in the ~~part~~selected section of the formation.

4093. (amended) The system of claim 4091, wherein ~~the at least one or more heat source of the heaters~~ comprise ~~comprises an electrical heaters~~heater.

4094. (amended) The system of claim 4091, wherein ~~the at least one or more heat source of the heaters~~ comprise ~~comprises a surface burners~~burner.

4095. (amended) The system of claim 4091, wherein ~~the at least one or more heat source of the heaters~~ comprise ~~comprises a flameless distributed~~ combustors~~combustor~~.

4096. (amended) The system of claim 4091, wherein ~~the at least one or more heat source of the heaters~~ comprise ~~comprises a natural distributed~~ combustors~~combustor~~.

4097. (amended) The system of claim 4091, wherein ~~at least the one or more of the open wellbores~~ comprise ~~comprises a diameter of at least approximately 5 cm.~~

4098. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation.

4099. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein the overburden casing comprises steel.

4100. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in

an overburden of the formation, and wherein the overburden casing is ~~further~~ disposed in cement.

4101. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein a packing material is disposed at a junction of the overburden casing and ~~the~~ at least one of the ~~one or more~~ open wellbores.

4102. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, wherein a packing material is disposed at a junction of the overburden casing and ~~the~~ at least one of the ~~one or more~~ open wellbores, and wherein the packing material is configured to substantially inhibit a flow of fluid between at least one of the ~~one or more~~ open wellbores and the overburden casing during use.

4103. (amended) The system of claim 4091, further comprising an overburden casing coupled to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, wherein a packing material is disposed at a junction of the overburden casing and ~~the~~ at least one of the ~~one or more~~ open wellbores, and wherein the packing material comprises cement.

4104. (amended) The system of claim 4091, wherein the system is further configured to transfer heat such that the transferred heat can pyrolyze at least some hydrocarbons in the partselected section.

4105. (amended) The system of claim 4091, further comprising a valve coupled to at least one of the ~~one or more heat source~~ heaters configured to control pressure ~~within~~ in at least a majority of the ~~partselected~~ section of the formation.

4106. (amended) The system of claim 4091, further comprising a valve coupled to a production well configured to control a pressure ~~within~~ at least a majority of the ~~partselected section~~ of the formation.

4107. (amended) A method of treating a hydrocarbon containing formation in situ, comprising:
providing heat from one or more ~~heat source~~heaters to at least one portion of the formation, wherein the one or more ~~heat source~~heaters are disposed ~~within~~ one or more open wellbores in the formation;

allowing the heat to transfer from the one or more ~~heat source~~heaters to a ~~partselected section~~ of the formation; ~~and~~

maintaining a temperature in the part of the formation in a pyrolysis temperature range;

and

producing a mixture from the formation.

4108. (amended) The method of claim 4107, wherein the one or more ~~heat source~~heaters comprise at least two ~~heat source~~heaters, and wherein superposition of heat from at least the two ~~heat source~~heaters pyrolyzes at least some hydrocarbons ~~within~~ the ~~partselected section~~ of the formation.

4109. (amended) The method of claim 4107, wherein ~~controlling formation conditions comprises maintaining a temperature within the selected section within a pyrolysis temperature range with a lower~~the pyrolysis temperature is from of about 250 °C to ~~and an upper pyrolysis temperature of about 400 °C.~~

4110. (amended) The method of claim 4107, wherein ~~the at least one or more heat source~~of the heaters comprises an electrical heaters.

4111. (amended) The method of claim 4107, wherein ~~the at least one or more heat source~~of the heaters comprises a surface burners.

4112. (amended) The method of claim 4107, wherein ~~the at least one or more heat source~~ of the heaters comprises a flameless distributed combustors.

4113. (amended) The method of claim 4107, wherein ~~the at least one or more heat source~~ of the heaters comprises a natural distributed combustors.

4114. (amended) The method of claim 4107, wherein the one or more ~~heat source~~ heaters are suspended ~~within~~ in the one or more open wellbores.

4115. (amended) The method of claim 4107, wherein a tube is disposed in at least one of the ~~one or more~~ open wellbores proximate to one of the heat source heater heaters, ~~the method further and~~ comprising flowing a substantially constant amount of fluid ~~into~~ in at least one of the ~~one or more~~ open wellbores through critical flow orifices in the tube.

4116. (amended) The method of claim 4107, wherein a perforated tube is disposed in at least one of the ~~one or more~~ open wellbores proximate to the ~~heat source heater~~, ~~the method further and~~ comprising flowing a corrosion inhibiting fluid ~~into~~ in at least one of the open wellbores through the perforated tube.

4117. (amended) The method of claim 4107, further comprising coupling an overburden casing to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation.

4118. (amended) The method of claim 4107, further comprising coupling an overburden casing to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein the overburden casing comprises steel.

4119. (amended) The method of claim 4107, further comprising coupling an overburden casing to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein the overburden casing is further disposed in cement.

4120. (amended) The method of claim 4107, further comprising coupling an overburden casing to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein a packing material is disposed at a junction of the overburden casing and ~~the~~ at least one of the ~~one or more~~ open wellbores.

4121. (amended) The method of claim 4107, further comprising coupling an overburden casing to at least one of the ~~one or more~~ open wellbores, wherein the overburden casing is disposed in an overburden of the formation, and wherein the method further comprises inhibiting a flow of fluid between ~~the~~ at least one of the ~~one or more~~ open wellbores and the overburden casing with a packing material.

4122. (amended) The method of claim 4107, further comprising heating at least the portion of the formation to substantially pyrolyze at least some hydrocarbons within in the formation.

4123. (amended) The method of claim 4107, further comprising controlling a pressure and a temperature within in at least a majority of the ~~part~~selected section of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

4125. (amended) The method of claim 4107, further comprising controlling a pressure within in at least a majority of the ~~selected section~~part of the formation with a valve coupled to at least one of the ~~one or more heat source~~heaters.

4126. (amended) The method of claim 4107, further comprising controlling a pressure within in at least a majority of the ~~selected section~~part of the formation with a valve coupled to a production well located in the formation.

4127. (amended) The method of claim 4107, further comprising controlling the heat such that an average heating rate of the ~~selected section~~part is less than about 1 °C per day during pyrolysis.

4128. (amended) The method of claim 4107, wherein providing heat from the one or more ~~heat source~~heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more ~~heat source~~heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within~~in the selected volume of the formation; and

wherein heating energy/day (P_{wr}) provided to the selected volume is equal to or less than $h * V * C_v * \rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate of the formation (h) is about 10 °C/day~~wherein heating energy/day provided to the volume is equal to or less than P_{wr} , wherein P_{wr} is calculated by the equation:~~

~~———— $P_{wr} = h * V * C_v * \rho_B$~~

~~———— wherein P_{wr} is the heating energy/day, h is an average heating rate of the formation, ρ_B is formation bulk density, and wherein the heating rate is less than about 10 °C/day.~~

4129. (amended) The method of claim 4107, wherein allowing the heat to transfer from the one or more ~~heat source~~heaters to the ~~selected section~~part comprises transferring heat substantially by conduction.

4130. (amended) The method of claim 4107, wherein providing heat from the one or more ~~heat source~~heaters ~~comprises heating the selected section~~part such thatincreases a thermal conductivity of at least a portion of the ~~selected section~~part is to greater than about 0.5 W/(m °C).

4143. (amended) The method of claim 4107, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, ~~and~~ wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

4146. (amended) The method of claim 4107, further comprising controlling a pressure ~~within~~in at least a majority of the ~~selected-section~~part of the formation.

4147. (amended) The method of claim 4107, further comprising controlling a pressure ~~within~~in at least a majority of the ~~selected-section~~part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

4148. (amended) The method of claim 4107, further comprising controlling formation conditions such that the produced mixture comprises a partial pressure of H₂ ~~within~~in the mixture greater than about 0.5 bar.

4150. (amended) The method of claim 4107, ~~wherein further comprising controlling formation conditions comprises~~ comprising recirculating a portion of hydrogen from the mixture into the formation.

4151. (amended) The method of claim 4107, further comprising altering a pressure ~~within~~in the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

4152. (amended) The method of claim 4107, further comprising:
providing hydrogen (H₂) to the heated ~~section~~part of the ~~formation~~ to hydrogenate hydrocarbons ~~within~~in the ~~section~~part; and
heating a portion of the ~~section~~part with heat from hydrogenation.

4154. (amended) The method of claim 4107, wherein allowing the heat to transfer ~~comprises~~ increasing ~~increases~~ a permeability of a majority of the ~~selected-section~~part to greater than about 100 millidarcy.

4155. (amended) The method of claim 4107, wherein allowing the heat to transfer ~~comprises~~ substantially uniformly increasing ~~increases~~ a permeability of a majority of the ~~selected~~

sectionpart of the formation such that the permeability of the majority of the part is substantially uniform.

4157. (amended) The method of claim 4107, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 ~~heat source~~heaters are disposed in the formation for the production well.

4158. (amended) The method of claim 4107, further comprising providing heat from ~~three or more heat source~~heaters to at least a portion of the formation, wherein ~~three or more of the heat source~~heaters are located in the formation in a unit of ~~heat source~~heaters, and wherein the unit of ~~heat source~~heaters comprises a triangular pattern.

4159. (amended) The method of claim 4107, further comprising providing heat from ~~three or more heat source~~heaters to at least a portion of the formation, wherein ~~three or more of the heat source~~heaters are located in the formation in a unit of ~~heat source~~heaters, wherein the unit of ~~heat source~~heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

4165. (amended) The method of claim 4107, wherein the mixture is produced from a production well, the method further comprising heating a wellbore of the production well to inhibit condensation of the mixture ~~within~~in the wellbore.

4167. (amended) The method of claim 4107, wherein the ~~selected section~~part is heated to a minimum pyrolysis temperature of about 270 °C.

4168. (amended) The method of claim 4107, further comprising maintaining the pressure ~~within~~in the formation above about 2.0 bar absolute to inhibit production of fluids having carbon numbers above 25.

4169. (amended) The method of claim 4107, further comprising controlling pressure ~~within~~in the formation in a range from about atmospheric pressure to about 100 bar, as measured at a

wellhead of a production well, to control an amount of condensable hydrocarbons ~~within~~in the produced mixture, wherein the pressure is reduced to increase production of condensable hydrocarbons, and wherein the pressure is increased to increase production of non-condensable hydrocarbons.

4170. (amended) The method of claim 4107, further comprising controlling pressure ~~within~~in the formation in a range from about atmospheric pressure to about 100 bar, as measured at a wellhead of a production well, to control an API gravity of condensable hydrocarbons ~~within~~in the produced mixture, wherein the pressure is reduced to decrease the API gravity, and wherein the pressure is increased to reduce the API gravity.

5396. (amended) The method of claim 4157, wherein at least about 20 ~~heat source~~heaters are disposed in the formation for each production well.